DESIGN AND DEVELOPMENT OF SOLAR DRIVEN LINEAR FRESNEL LENS BASED WATER PURIFICATION SYSTEM

SYNOPSIS

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1. Title

DESIGN AND DEVELOPMENT OF SOLAR DRIVEN LINEAR FRESNEL LENS BASED WATER PURIFICATION SYSTEM

2. INTRODUCTION

With the increase of population in the world, shortage of potable water is becoming more noticeable. About 70% area of earth is covered with water. Out of which 98% is salt water and only 2% is fresh water, of that 1.6% is polar ice caps and glaciers, 0.4% is drinkable water from underground wells, rivers, , streams etc. Roughly one billion people or 14.7% of earth's population do not have access to clean, safe and drinkable water.

Pure water is not available in nature. Water evaporates into atmosphere, condenses and falls back to the ground and certain gases like oxygen, carbon dioxide, bacteria and dust absorbed from the air. When this water comes to the ground, many more organic and non- organic chemicals, micro- organisms and organisms are dissolved from the rivers. Some of the rainfall percolates into the soil, loosening suspended silt and bacteria. There is also the danger of contamination by radio- active isotopes in the ground water. Contaminants from the ground's surface include municipal, industrial and agricultural wastes. These wastes wash into rivers and also infiltrate the ground water.

Therefore, waste water requires certain level of treatment before it is going to contact ground water and domestic water should also be treated before drinking.

WHO has some guidelines for five categories of contaminants for drinking water as follows:-

1. Microbiological and biological standards (micro-organisms and other organisms)
2. Inorganic constituents that pose health risks (arsenic, cadmium, nitrate, lead and sodium)
3. Organic constituents (benzene, phenols, dichlorodiphenyltrichloroethane (DDT) and others)
4. Aesthetic guidelines (odor, taste, hardness and color)
5. Radio- activity guidelines (mostly for ground water)

In rural areas water is disinfected using a chlorine solution. Simplest method of disinfecting water is to boil it for its purification. However, boiling is quite expensive and consumes a large amount of fossil fuels. Wood gathering leading to the depletion of forests. According to the world bank report, more than $50 million per year is spent in Jakarta, Indonesia just for fuel to boil water in household. RO systems are now being installed in urban areas. However, they are having disadvantage that almost 30% water is wasted and it requires electricity.

Renewable energy sources have been used directly or indirectly for the treatment of water. There are different methods for water purification using solar system:-

- Solar still
- Solar Collector (using reflector)
- Fresnel lens

Purification of water using solar still is a very old and slow process. As the solar energy is having certain drawbacks due to its dependence on geographical conditions. So, it becomes quite important to utilize the solar energy efficiently. So, the concentrating technologies are becoming more prominent in these days.

In concentrating technologies Fresnel Lenses recently becomes one of the best choice due to their small volume, lighter weight, more production with low cost as well as increase the energy density.

To achieve the high concentrating energy efficiencies, tracking system will also be implimented. So there is no need to change the focus of Fresnel lens.

Need and Significance of Proposed Research Work

- About 833 million people in India reside in the rural regions. Providing them a safe drinking water is great challenge.

According to United Nation's report:

- Annually over 1 lakh people die of water borne diseases.
- 37.7 million people affected annually due to unavailability of safe drinking water.
- About 25% of Indian villages have no protected drinking water sources.
- 73 million working days lost yearly due to water- borne disease.
- $600 million economic burden yearly on India.

Therefore, it is required to develop a water purifier system which have minimal cost and easily purify water in rural areas.

Objectives

The following are objectives of the proposed research work as given below:-

1. To analyze the Physic-Chemical properties of contaminated different water samples.
2. To design and develop a water purifier system using Linear Fresnel Lens.
3. To analyze the designed system for optimum efficiency.
4. Performance evaluation of the designed system**.**

3. EXPECTED OUTCOMES

There are some regions where it is not possible to get naturally purified water. Also there is no excess of electricity. Psycho-chemical properties of water will be studied, so that we will come to know about the contamination in the water. A model based on solar energy will be developed which can work in rural and backward area. This work will lead to fuel saving and

minimize the emission of carbon leading to the reduction of environmental pollution. This work provides the estimation of efficiency of Linear Fresnel Lens based prototype water purifier system and production cost.

4. REVIEW OF LITERATURE

The water is one of the natural resource and very much needed for sustaining life on the earth. But in the present era due to the various anthropogenic pressure the availability of the safe water for the is decreasing dramatically. Pathak et. al. (2014) given the brief about the total water available, utilized for various purposes, cause of pollution in water, how a water efficiency can be increased and effect of climate change on water in India. This decrease in water availability is very much dependent on its utilization. Therefore can be vary region to region. The different anthropogenic deeds needs different amount of water such as industries pharmaceutical's, sugar, distillery, paper, mining, manufacturing of different modern equipment and gadgets along with the daily human needs such drinking, cooking, irrigation and sanitation. Therefore, in the present era there is a huge pressure of the natural water and various techniques are used for purification/decontamination of the water for enhancement of the reusability of the polluted water. The effluent treatment plant is one of the method used by the industries to decrease the pollution load from the discharged water but the reused efficiency is very much low due to its high impurity.

Szulmayer and Nelson both presented and investigated a solar concentrator based on linear Fresnel lens, which could reach temperatures between 60 and 143 ^{0}C for water heating, steam production, desiccants (silica gel) regeneration, as well as thermoelectric power generation (Szulmayer et. al.1973,1980). A 0.457 m diameter Fresnel lens focused sunlight onto the hot end of a 0.0254 m diameter reticulated vitreous carbon prime mover stack, heating it to 475 ^{0}C, (Adeff et. al. 2000).

Anurag Swain (2016) has designed a system to run the Water Treatment Plant by Solar with 3-4 hours battery back-up time. He set up Solar Power SMART RO Plant in rural & semi urban area association with CSR ,Gram Panchayat & Companies, to provide safe & hygienic drinking water at a reasonable price. Deepak Devasagayam et. al. (2015) has reviewed all the available research and technology for water distillation using solar energy. It is found from the literature survey that, a number of research setups and devices are available but are currently not being used due

to high initial setup costs and limited technological awareness in the society. V.S.Rajashekhar et. al. (2014) has designed a solar water purification plant that operates around the clock to supply fresh water to the society. A nickel-chromium alloyed wire reinforced black body has been used to heat the impure water and it condenses on a thermally insulated condenser. Two solar panels have been attached the sides of the reflector that moves along with it to trap the solar energy and store it in a battery. During night and at times of low sun rays, this electric energy can be used to heat the nickel-chromium alloyed wire reinforced black body. These functions are controlled by a microcontroller.

Deepak Devasagayam et. al. (2014) has design a solar water purification system based on carbon filter. After this initial filtration by carbon filter, water is then passed to evacuated vacuum tubes for remaining purification. Parabolic trough is used to heat the evacuated tubes. The design is meant to provide 25 liters of water per day and will be best usable during the summer seasons in India. The estimated cost of his purifier system is around Rs15850/-. Jinesh S. Machale et. al. (2013) has address challenges like low yield and relatively high initial investment costs for water purification system by using solar water purification by Concentrating Solar power (CSP) technology to realize a small scale single slope solar still for personal use with adequate efficiency and at low production costs.

Gaurav A. Madhugiri et. al. (2012) has discussed the application, the ongoing research and development works suggest that Fresnel lens solar concentrators will bring a breakthrough of commercial solar energy concentration application technology in the near future. He also focused on the Solar Energy high temperatures using parabolic solar concentrator, Fresnel lens, Reflecting materials and solar tracking. It identified their level of performance. The research provides an up-to-date review of solar concentrators and their benefits to make solar technology affordable. It will also analyze on some of the existing solar concentrators used in the solar technology for the past four decades and performance of each concentrator will be explained and compared. S.S.Phuse et. al. (2012) proposes water purification system for remote areas focus on providing a pure drinking water at low cost with high reliability to the rural families. It involves the research, design and manufacture of water purification system using renewable energy . It consist of a combination of solar pasteurization, reverse osmosis (RO) and ultraviolet (UV) lamp sterilizer system with power supplied by photovoltaic (PV) modules.

W.T. Xie et. al. (2011) has done the review of applications of Fresnel Lens technology. He has stated that Fresnel lens solar concentrators, especially non-imaging Fresnel lenses, will bring a breakthrough of commercial solar energy concentration application technology in the near future. The advantages and disadvantages of two systems are also summarized. Mohamed Salah Mahmoud et. al. (2011) demonstrates experiments for solar water desalination by humidification-dehumidification process. The work was done in two stages each of them is of equal importance. The results for water heating by Fresnel lens showed that the theoretical yield was not accomplished due to energy loss by radiation; also the experiment showed that hot water yield depends on water flow rate. The results for water desalination experiment showed a maximum water production of 106 cm3 /h for each liter of saline water.

William S. Duff et. al. (2005) has designed, built and tested a new passive solar water pasteurization system based on density difference flow principles. The system contains no valves and regulates flow based on the density difference between two columns of water. The system with a total absorber area of 0.45 m2 has achieved a peak flow rate of 19.3 kg/h of treated water.

5. TECHNICAL PROGRAMME

Methodology

Objective 1.

Water samples will be collected from different locations of Baru Sahib. Collected samples will be tested in in laboratory. Standard analytical methods will be followed in the analysis of water samples. Different equipment will be used for the testing of water samples.

Objective 2.

Different geographical conditions of Baru Sahib will be studied for the solar radiations. Depending on the measurements design of the system for the purification of water will be carried out. Calculations for the thermal conductivity of the model will be carried out. Material for the development of system will be purchased. Working model will be developed in the workshop.

Objective 3.

Depending on the tilt angles Linear Fresnel Lens will be situated. Data will calculated for the sunny days. Depending on that flow of water will be checked. Amount of water purified per hour will be checked.

Objective 4.

System performance will be evaluated. Purified water samples will be checked in laboratory and compared with Indian water standards. Sun tracking system will be installed for better efficiency. Performance of system will be studied.

Different tests to be conducted:-

- Physical Test: Odor, Color, Turbidity, pH, Electrical conductivity, Total dissolved solid, Total suspended solids,
- Chemical Test: Nitrogen, Potassium, Chloride, Phosphorous, Sodium, Dissolve Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Heavy Metals
- Biological/microbiological Test: If required

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Signature of Student